

DISCUSSION

Pedro Galindo:¹ I would like to discuss possible methods of controlling the species of *Culex* (*Melanoconion*) involved in the transmission of the endemic viruses of Venezuelan encephalitis (VE) in Central America and Panama. According to the types of breeding places utilized by these species, we may divide them into two broad categories: (1) species found in deeply shaded ground pools of various types, examples of which are *C. vomerifer*, *C. taenioptus*, *C. epanastasis*, *C. opisthopus*, and *C. spissipes*; and (2) mosquitoes that prefer open, sunlit breeding areas more or less covered with a variety of aquatic vegetation, such as *C. aikenii*, *C. dunni*, and *C. paracrybda*.

Of the species found in deeply shaded ground pools, *C. taenioptus*, *C. vomerifer*, *C. spissipes*, and *C. opisthopus* breed in extensive swampy forests under a variety of conditions, but always in the presence of large forest palms or trees. The larvae are closely associated with the trunks of the palms or the buttressed roots of the trees and scattered over a large area. On the other hand, *C. epanastasis* breeds by preference in the clear, cool water contained in the galleries of rodent burrows flooded by a rising water table. It is obvious that attempts to control these species by attacking the immature stages would involve very high expenditures of funds which are not now warranted in the light of the amount of human disease produced by the bites of these insects. However, in studying the adult habits of these species in the vicinity of the port of Almirante in Panama, we find that it is possible to minimize transmission of VE virus to man by applying low-cost methods of control against the adults.

It has been determined that all five species mentioned above feed only between the hours of dusk and dawn and that all of them attack man readily. Only *C. vomerifer*, *C. opisthopus*, and

C. taenioptus have been taken in numbers around human habitations, however, while *C. epanastasis* and *C. spissipes* remain within the forest habitat, so that man is seldom bitten by them except when visiting the swampy forests at night, which is a rare occurrence. In the case of *C. vomerifer*, *C. taenioptus*, and *C. opisthopus*, it has been found that they fly out of the forest habitat and in numbers invade peridomestic areas where they have ample opportunity to feed on people, thus constituting important species in the transmission of VE virus from the enzootic cycle to man.

Ecologic investigations of these three species in Almirante reveal that they do not enter houses to feed, but that they do attack humans on open porches and in other enclosures, such as spaces under elevated houses, particularly in the early evening. Since these mosquitoes require a high relative humidity to survive as adults, they do not invade the peridomestic habitat unless this humidity requirement is met in the form of swampy fingers protruding from the forest to the general vicinity of human communities, or by the presence of abundant vegetation around the houses such as large shade trees or thick bushes and shrubbery. If such vegetation is removed and the peridomestic environment is kept relatively dry, a buffer zone is created which *C. taenioptus*, *C. vomerifer* and *C. opisthopus* are unable to cross.

In areas of Almirante where such sanitation measures have been taken, bites of these mosquitoes have been reduced to a minimum, thus lessening the danger of human infections with VE virus. Since all human communities subject to the danger of VE infection are also within the malaria-transmission zone, it is recommended that residual DDT spraying of houses, as carried out in malaria eradication campaigns, should also cover places such as open porches and underneath houses since these measures would certainly help to reduce peridomestic populations of *Culex* (*Melanoconion*).

¹ Gorgas Memorial Laboratory, Balboa Heights, Canal Zone.

The second species group is that breeding in open, sunlit waters in the presence of abundant aquatic vegetation. Three *Melanoconion* species that fall in this category have been found naturally infected with VE virus in Panama, namely, *C. aikenii*, *C. dunni*, and *C. paracrybda*. The last two species are not very common and hardly ever come in contact with man, so attention will be devoted here only to the control of *C. aikenii*.

Biting activity of *C. aikenii* adults seems to indicate that this mosquito's contact with man is rather infrequent. The species readily attacks humans in the open after dusk but it does not enter human dwellings in search of blood. It has the habit of biting very low, usually below the ankles, so the possibilities are very remote that a man wearing shoes and long pants would ever be bitten by *C. aikenii* females. The fact that transmission of VE among rodents inhabiting the banks of the Chagres River is intense (2), yet people who frequently boat and fish along the river seldom acquire the disease, seems to confirm this hypothesis. There is some evidence, though, that a small VE outbreak among U.S. troops camping near Garún Lake in the Panama Canal Zone may have been transmitted by this mosquito (1).

Intense VE activity in the rodent population may be locally reduced by attacking the immature stages of *C. aikenii*, which congregate in large numbers in communities of the aquatic floating plant *Pistia stratiotes* or water lettuce.

Panama Canal Zone authorities have utilized two methods of attack on the breeding places of *C. aikenii* with some success. One is by spraying a herbicide, 2-4-D, mixed with diesel oil and water at a 1:1:200 ratio to kill the host plant (4). This action leaves the larvae without the protection of the *Pistia* leaves and they soon perish or are devoured by the large populations of predators sustained by the water-lettuce communities. This treatment works well but has to be repeated frequently since the *Pistia* plants germinate rapidly and vigorously again after such a treatment, soon covering large areas of the river banks. The second method utilized with slightly less success has been the application of a 10 per cent DDT powder by a motor-driven power duster mounted on a boat. This treatment is repeated along the inlets of the Chagres once a week throughout the year (3). Populations of *C. aikenii* are affected locally in areas where the wind drifts the powder in the right direction and VE infection rates in sentinel hamsters drop sharply.

In summary, the control of *Culex* (*Melanoconion*) mosquitoes depends greatly on their ecology. For some species that breed scattered over large expanses of permanently flooded forest, adulticiding is recommended. For those species breeding in sunlit waters with abundant growth of aquatic vegetation, such as *C. aikenii*, the method of choice is destruction of the vegetation with herbicides such as 2-4-D and secondary larviciding with insecticides.

REFERENCES

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